MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. LVIII. APRIL 6, 1898. No. 6

Sir R. S. BALL, M.A., LL.D., F.R.S., President, in the Chair.

Captain Vernon L. D. Broughton, Hillside, Godstone, Surrey;
Charles Friswell, 34 Madeley Road, Ealing, W.;
Professor C. J. Joly, M.A., Royal Astronomer of Ireland, The Observatory, Dunsink, co. Dublin; and
William Ritchie, 75 Morningside Road, Edinburgh,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended :—

Henry Ellis, Little Heath, Potter's Bar (proposed by J. G. Petrie);
Peter Matthews, Solicitor, 102 Fenchurch Street, E.C., and 65 Gordon Mansions, W. (proposed by Thomas Mackenzie);
Captain P. B. Molesworth, R.A., Trincomali, Ceylon (proposed by E. W. Maunder);
W. J. Reynolds, 61 Fairholt Road, Stamford Hill, N. (proposed by F. W. Dyson); and
William Edward Sparkes, Stockbroker, 5 Roker Terrace, Sunderland (proposed by Cuthbert Hutchinson).

Sixty-eight presents were announced as having been received since the last meeting, including amongst others :—

Ph. Fauth, Beobachtungen der Planeten Jupiter und Mars, 1896–97, III. ; J. N. Krieger, Mond-Atlas, Band I. ; A. Stanley Williams, Catalogue of the magnitudes of 1081 southern stars, presented by the authors ; Paris Observatory, Atlas photographique de la lune, par MM. Lœwy et Puiseux, fasc. 2 ; Potsdam Observatory, Publicationen, Band XI. ; presented by the Observatories ; Set of transparencies from negatives of the total solar eclipse of 1898 January 22, presented by the Astronomer Royal ; Photographs of the total solar eclipse of 1898 January 22, presented by C. Thwaites.

The Spectrum of o Ceti as photographed at Stonyhurst College Observatory. By the Rev. Walter Sidgreaves, S.J.

The series of photographs of the spectrum of *o Ceti*, obtained during the recent favourable period of its maximum light, consists of 20 plates, on 15 nights, beginning with 1897 November 18, and ending on 1898 February 5. Six of these were taken in November on the dates 18, 23, 24, 28, 29 ; twelve in December on dates 1, 2, 11, 15, 19, 24, 25, 28, 30 ; one on January 7, and one on February 5.

All the photographs are upon Edwards' Isochromatic plates, excepting the one of December 30, which is on a Mawson plate. All are good photographs ; but the accompanying tables of wave-lengths (p. 348), and the map of the spectrum (plate 3),* are formed upon one plate, that of November 29, supplemented, in the violet, by the Mawson plate of December 30. These were judged to be the best of the series. Eleven other plates were selected for measures of the sharp edges of the bands, to serve as a check upon the scale readings used for the map and tables.

The map has been executed with the greatest care, to represent as closely as possible the relative radiation-energy of each part of the spectrum as it arrives upon the plate, allowance being made everywhere for the sensibility curve of Edwards' Isochromatic plate ; and this curve has been estimated upon the supposition of uniform energy at all the parts of the spectrum of *α Tauri*.

The spectrum has apparently remained substantially constant during the period of observation. But a marked change in the relative intensities of the yellow-green and the blue radiations

* Two photographic mounts presented to the Society with this Paper are reproduced as Plate 1 and Plate 2. They are direct enlargements from the original negatives, widened by a cylindrical lens. All the lines have been verified by comparison with enlargements made without the cylindrical lens. They do not show all the details of the original negatives.

appears to have taken place during the cloudy week between December 2 and December 11. On all the preceding dates the photographs show the maximum silver deposit in the blue region of the spectrum ; and on all the subsequent dates the yellow-green radiation has produced a stronger impression. This alteration is illustrated by three enlargements on Plate 1.

Of the hydrogen lines H_ϵ is still absent, lost, or much weakened in the calcium absorption ; and H_β may be visible as a division of the band which begins at λ 4842. This division of the band is at 4861, the position of H_β, and is, on this account only, entered in Table I. as a bright line, but without an estimated intensity, the brightness being less than that of the continuous spectrum. But it is not easy to reconcile the comparatively weak absorption at this part of the band in *Mira* with its supposed absorbing action on the very energetic radiation of H_β. The hydrogen tubes in the laboratory give H_β very greatly over-exposed, when the time has been long enough to give H_ϵ the precise character of the line on the star plates. And we have to take into consideration the extraordinary brilliancy of the two lines H_ϵ and H_γ in the star's spectrum : it is too great to be shown on a drawing, or to be safely expressed by a number representing relative intensity. These lines are so strong on the negatives that it is not easy to darken them on a positive enlargement by over-exposure ; and they remain perfectly clear, when the over-exposure has been long enough to darken greatly all the other bright zones of the spectrum. It seems more probable that *o Ceti* shows a condition of hydrogen radiance not yet met with in the laboratory, in which H_α and H_β have fallen out of the spectrum.

Professor Keeler's remark on the spectrum of *α Herculis* is applicable to the spectrum of *o Ceti*. He says,* "It is impossible to avoid the conclusion that the edges of the zones bordering on the dark bands are bright—much brighter, that is, than the average continuous spectrum." These zones are given in Table I. according to our estimate of the relative intensities representing continuous spectrum.

The band having its sharp edge at λ 5162 has been the subject of careful examination. The question at the beginning was whether we had to deal with a bright fluting shading towards the violet or not. Our judgment of the brightness of this region, referred to the continuous spectrum as zero, is given in Table I. in favour of a possible bright band. But there is an absorption band shading from the same position, 5162, in the opposite direction. Of this there can be but little doubt ; it is impossible, without it, to interpret the photographs consistently with the sensibility curve of the isochromatic plate, unless we suppose the green radiation to be less energetic in this class of stars than in stars nearer to the solar type. The two bands, one bright and

* *Astronomical Journal*, vi. 5, p. 424.

fading towards the blue, the other dark and shading towards the red, cannot well stand together with a common termination ; and there is no appearance of overlapping, which ought to manifest itself as a pale separating band. For this reason our photographs seem to be against the carbon origin of the brightness at λ 5162.

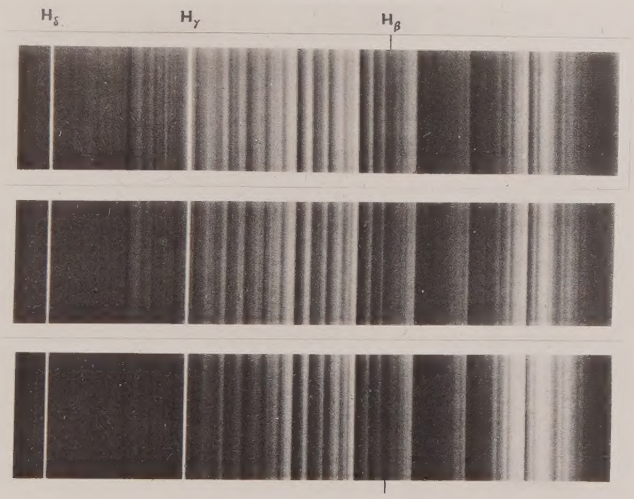
In Plate 2 the position of *o Ceti* in Secchi's third type, in gradations towards the second type, is shown by comparison with the spectra of other stars, in the order *α Herculis*, *β Pegasi*, *η Geminorum*, *α Orionis*, *β Andromedæ*, and *α Tauri*. It is more remote from the solar spectrum than *α Herculis*. Its bands or flutings are stronger, as noted by Lockyer in 1893, but the chief differences between the two spectra, omitting the hydrogen lines, are the more decided fluting character of the bands of *o Ceti* on the violet side of λ 471, and the remarkably strong radiation of *α Herculis* between λλ 4227 and 4458.

The line spectrum of *o Ceti* places the star in Lockyer's subdivision *α* of Table C. He finds, besides hydrogen, iron, manganese, calcium, chromium, cobalt, titanium, and strontium, common to them all,* and the calcium lines intensified, as compared with those in the solar type of spectra. The strong absorption line† in the photographs of Plate 1, between H_δ and H_γ is at λ 4227, and is therefore probably the strong calcium line at 4227. Another strong line on the more refrangible side of H_δ, very distinct on the negatives, is at λ 4077, the position of one of the strongest strontium lines. Other lines are equally precise coincidences with known strong lines in the arc spectra of strontium and iron. In Table II. of wave-lengths a comparison column is added for the spectra of iron, and other metals in which all and only those lines are entered which have the note of full intensity in Watts' Index of Spectra, within the limits of the photograph. The brackets in the column of band numbers show the widths of the bands, and enclose the superimposed lines. A band terminates with a spectral line when the terminating wave-length is not enclosed in a round bracket. The round bracket signifies the termination only, and not a line. A square bracket covering a number of wave-lengths within a band signifies that these would not be seen as separate lines without careful examination of the original plates.

The grouping of the bands is not marked in the table of wave-lengths. But it is very apparent on the photographs : they run in quartets, with deepest absorption on the violet sides, and general shading towards the red sides. These appear as single bands in the smaller spectrum given by a half prism and short focus camera.

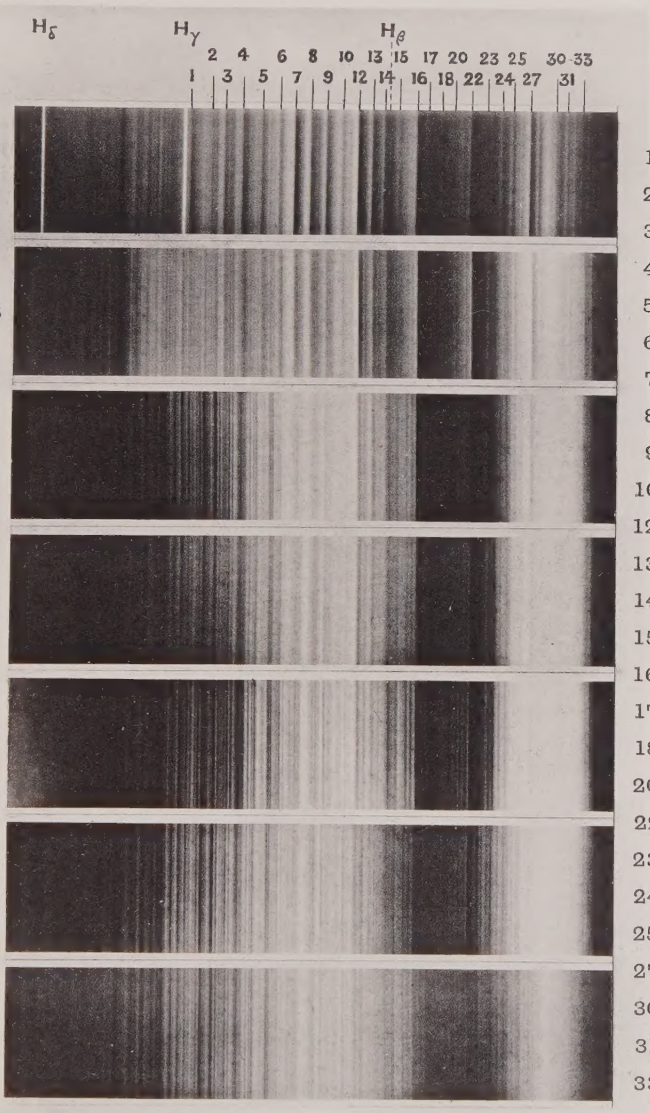
* *Phil. Trans.* vol. clxxxiv. p. 705.

† This line appears on all the photographs of Plate 2, but not with its proper strength, this end of the spectrum having been sacrificed in the original negatives in order to bring out the lines in the more sensitive part of the plate. It shows as the strongest absorption line in the spectrum of *α Tauri* on plates of long exposure.



SPECTRUM OF o CETI, SHOWING A PROGRESSIVE CHANGE IN THE RELATIVE RADIATIONS OF THE BLUE AND YELLOW REGIONS, STONYHURST COLLEGE OBSERVATORY

Spottiswoode & Co. London



PROGRESSIVE STELLAR SPECTRA BETWEEN SECCHI'S 3RD AND 2ND TYPES
STONYHURST COLLEGE OBSERVATORY

Spottiswoode & Co. Lond

A close examination of the enlarged photographs of Plate 2 shows a marked difference either in the real positions of the sharp edges of the bands, or in the lengths of the photographed spectra. In the latter supposition *o Ceti* shows a shorter spectrum, and *α Herculis* a longer one than *β Pegasi* or *α Orionis*. These differences are not owing to inexactness of enlargement. They were shown on the original plates, by the micrometer, before the enlargements were made. It is impossible to escape the conclusion that they are owing to some instrumental defect; but so far the cause is not clear. Something may be set down—1st, to the relatively great flexure of the telescope tube, owing to the form of mounting necessary for the adaptation of the large object glass; 2nd, to imperfect centering of the light rays through the prism; 3rd, to micrometer imperfections; and, 4th, to differences of temperature. But the maximum effects of these have been measured, and found to be insufficient, when taken together, to account for the differences. There remains only the photographic effect of longer exposure, corresponding to the widening of a bright line. This would be to increase the length between the fiducial position, H_γ, and the edges of the bands in the green-yellow regions; but that no appreciable effect of this nature can be admitted in the photographs is shown by two exposures on the night of November 23. One of these was by a slow trail corresponding to a long exposure, and the other by a very quick trail. The latter gave a weak photograph with excellent definition, to compare with the strong photograph of the longer exposure; and both exposures were upon the star at the same average altitude, east and west of the meridian. The positions of the bands by both plates were the same.

With these considerations before us we are forced to admit the probability of a real difference between the positions of the strong edges of the bands in *o Ceti* and in *α Herculis*, as compared with the remaining stars of Plate 2. These differences appear in the following table of positions of the edge of Duner's band 5 (No. 27 of our photographs on Plate 2).

	Edge of Band.
o Ceti	5447
β Pegasi	5451
α Orionis	5451
α Herculis	5458

TABLE I.

Bright Lines, and possible Bright Bands, in the spectrum of o Ceti.

	Wave-length.	Intensity.	Remarks.
H_δ	4101	10	Sharp line.
H_γ	4340	10	,, ,,
1	4566 4580	1	
2	4608 4622	1	
3	4700 4756	2	
	4861		Presumably H_β: a faint narrow division in a broad absorption band.
4	4924 4950	2	
5	5114 5161	2	
6	5374 5446	2	

TABLE II.

Absorption Spectrum of o Ceti.

o Ceti.				o Ceti.			
Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.	Band Nos.	Wave-lengths.	Intensity and Character	Strong lines of Iron, &c.
	4052	2			4116	1	
	4059	1 *f*			4123	1 *f*	
	4063	1 *f*	4063 Fe		4128	2	
	4068	2	4071 Fe		4133	2	4131 Fe
	4077	4	4077 Sr		4142	2	4143 Fe
	4082	1			4151	2	
	4088	1			4156	1 *f*	
	4095	1 *f*			4164	1 *f*	4163 Ti
	4098	1 *f*			4169	2	4171 Ti
	*4105	2			4176	3	
	4112	1 *f*			4180	2 *f*	

w = wide line
f = narrow or fine
b = band.

* See bright line spectrum (Table I.)

o Ceti.

Band Nos.	Wave-lengths.	Intensity and aracter.	Strong lines of iron, &c.
	4187	2	4187 Fe
	4192	2	4191 Fe
	4199	2	4199 Fe
	4205	2	4202 Fe
	4215	4	4215 Sr
	4222	4 *f*	
	4227	10 *w*	4227 Ca, Mn
	4231	4 *f*	
	4236	2	4235 Mn
	4242	2	
	4247	1 *f*	
	4251	2 *f*	4250 Fe
	4256	3	4254 Cr
	4262	2	4260 Fe
			4271 Fe
	4273	3 *w*	4272 Mn
			4275 Cr
	4282	1	4281 Thorium
	4290	2	4289 Cr
	4299	2	4299 Fe Ti
	4302	1 *f*	4302 Ca
			4305 Sr
	4308	1	4307 Fe
	4315	2	4315 Fe
	4320	1	
	4326	1	4325 Fe Mn
	4333	1	
	4337	1	4337 Fe
			4338 Ti
	*4345	2	
1	(4352)	7	
	4354	7	
	4359	6	4358 Hg
	4363	2 *f*	
	4369	3	
	4373	3	
	(4375)	2	4379 Vanadium
			4382 Thorium

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
	4385	3	4383 Fe
			4384 Vanadium
	4392	2	4393 Ti Tho
2	(4395)	5	
	4397	5 *w*	
	4407	5 *w*	4405 Fe
			4408 Vanadium
	(4409)	5	
	4415	1 *f*	4415 Fe Mn
3	(4420)	4	
	4421	4 *f*	
	4424	6 *w*	4425 Ca
	4429	4	4427 Ti
	4435	5 *w*	4435 Ca
			4442 Fe
	4442	4	4443 Ti
			4436 Mn
	4450	2	4447 Fe
			4451 Mn
4	(4458)	6	4454 Ca
			4455 Mn
	4459	6 *f*	4457 Mn
			4461 Mn
	4463	7 *w*	4464 Mn
	4470	6	4469 Ti
			4470 Mn
	4474	5	4472 Mn
			4475 Fe
	4480	3	4482 Fe
	4486	2	
			4489 Mn
	4494	2 *f*	4494 Fe
	4496	2 *f*	4498 Mn
5	(4502)	6	4501 Ti Mn
	4504	6	
	4506	6	
	4514	5	
	(4517)	5	
	4523	2 *f*	4524 Sn
	4526	2 *f*	4526 Ti
			4528 Fe
	4533	2 *f*	

w = wide line. *f* = narrow or fine. *b* = band.

* See bright line spectrum (Table I.)

Band Nos.	o Ceti. Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
	4537	1 *f*	4536 Ti
6	(4544)	5	
	4546	5 *w*	4549 Ti
	4551	5	
	4560	2	
	4565	1	
	4571	1 *f*	4572 Ti
	4575	1 *f*	
7	(4581)*	10	
	4583	10 *w*	
	4589	10 *w*	
	4599	4	4602 Fe
	4605	4	
	(4607)	4	4607 Sr
	4613	1 *f*	
	4617	1 *f*	
*	(4623)	8	
8	4626	8 *b*	
	4635	7 *w*	
	4646	5 *w*	4639 Ti
	4653	3	4654 Fe 4656 Ti
	4660	1 *f*	
9	(4667)	9	4666 Fe
	4670	9 *w*	
	4675	8	4678 Fe 4679 Zn
	4683	3	
	4692	2	4691 Fe
	4697	2	
	(4699)	2	
	4708	1 *f*	4707 Fe 4709 Mn
10	(4713)	4	
	4715	4 *w*	
	4723	3	4721 Zn
	(4725)	3	4726 Mn

Band Nos.	o Ceti. Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
11	(4735)	3	
	4738	3	4736 Fe
	4744	2	
	4750	1 *f*	4753 Mn
12	(4757)*	10	4757 Ti 4759 Ti
	4759	10	4761 Mn
	4765	10	4765 Mn
	4771	10	
	4782	6 *w*	4779 Co 4782 Mn
	4789	4	
	4794	2	4792 Co
13	(4803)	6	
	4804	6	4804 Ti
	4808	10	4809 Zn
	4811	9	
	4824	4	4814 Co 4823 La Di Mn
	4831	4	
	(4834)	2	
14	(4842)	8	4840 Co
	4843	8	
	4849	9 *w*	
	4855	8	4855 Ni 4859 Fe
	4869*	6 *b*	4866 Ni 4871 Fe
	4881	4	4873 Ni 4877 Fe
	(4884)	4	4885 Ti
15	(4892)	3	4891 Fe
	4897†	6 *b*	4899 La Di
	4908	2	4911 Zn
	4917	3	4919 Fe
	4922	2	4920 La Di 4921 La Di
	4934	1	
	4937	1	

w = wide line. *f* = narrow or fine. *b* = band.

* See bright line spectrum (Table I.) † Probably a triplet.

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
16	(4951)*	10	
	4954	10 *b*	4957 Fe
	4963	10 *b*	
	4981	8 *b*	4981 Ti
	(4986)	8	4990 Ti
17	(4998)	9	4999 Ti
	5003	9 *b*	5001 Fe
			5006 Fe
	5018	7 *b*	5007 Ti
			5013 Ti
	5035	5 *b*	5036 Ti
	(5039)	5	
18	(5046)	6	
	5050	6 *b*	5049 Fe
	5062	6 *b*	5064 Ti
	(5066)	6	5068 Fe
19	(5074)	3	
	5077	4 *w*	
	5085	4 *w*	
	(5088)	3	
20	(5098)	4	
	5099	4	
	5107	5 *w*	
	5112	3	5120 Ti
	5124	2 *w*	5129 Ti
21	(5135)	3	
	5139	3 *w*	5139 Fe
	5148	3 *w*	
	(5151)	3	

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
22	(5162)*	10	
	5165	10 *w*	5167 Fe Mg
	5171	10 *w*	5171 Fe
	5185	8 *b*	5172 Mg
			5183 Mg
			5191 Fe
	5201	8 *b*	5193 Ti
			5204 Cr
			5206 Cr
	5212	8 *b*	5208 Cr
			5210 Ti
	5224	4 *w*	5223 Ti
			5226 Fe
	(5227)	4	5232 Fe
23	(5237)	8	5238 Sr
	5244†	8 *b*	
			5265 Fe
	5265†	8 *b*	5268 Fe
			5269 Fe
	5280	7 *b*	5283 Fe Ti
			5297 Ti
	5292	3	5301 Fe
			5327 Fe
24	(5306)	7	
	5310	7 *b*	
	5320	7 *b*	
	5335	4 *b*	5337 Ti
	5344	3	
	(5346)	3	
25	(5356)	6	
	5358	6	
	5364	8 *w*	
	5371	5	5371 Fe
	(5373)	5	

w = wide line.
f = narrow or fine.
b = band.

* See bright line spectrum (Table I.)
† Probably a double.

Band Nos.	o Ceti. Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
	5385	1	
	5391	1	
26	(5406)	2	5405 Fe
	5409	2 *w*	
	5416	1	5415 Fe
	(5418)	1	5423
	5431	1 *w*	5428 Fe
27	(5447)*	10	5433 Fe 5446 Fe
	5450	10 *b*	
	5460	10 *b*	5455 Fe 5460 Hg
	5473	7 *w*	5475 5477 } Uranium
	5479	7 *w*	5480 Sr 5479 Uranium
	5486	3	5482 Uranium
28	(5498)	5	5494 Uranium
	5499	5	
	5503	9 *w*	
	5514	5 *w*	5512 Ti 5513 Ti
	5527	3 *w*	5527 Uranium
	5536	3 *w*	
	(5539)	3	
	5548	1	
	5559	2 *w*	5562 Sn
29	(5570)	7	
	5574	7 *b*	5571 Fe
	5587	4 *w*	5586 Fe 5587 Ca
	(5589)	4	5588 Sn

Band Nos.	o Ceti. Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
30	(5597)	8	5597 Fe
	5603	8 *b*	5602 Fe 5615 Fe
	5626 †	9 *b*	
	5642	7 *b*	5643 Ti
	(5647)	7	5658 Fe
31	(5660)	7	
	5661	7	5662 Ti
	5667	8 *w*	
	5674	7	5674 Ti
	5689	5 *w*	
	5696	3	
	(5698)	3	
32	(5709)	3	
	5710	3	5708 Fe
	5720	5 *b*	
	5739	4 *b*	
	(5745)	4	
33	(5756)	8	
	5761	8 *b*	5768 Hg
	5771	8 *b*	5790 Hg
	5792	3 *b*	
	(5796)	3	5798 Sn
34	(5804)	8	
	5808	8 *b*	
	5821	8 *b*	
	(5827)	8	
35	(5840)	8	
	5845	8 *b*	
	5857	8 *b*	
	(5862)	8	

w = wide line.
f = narrow or fine.
b = band.

* See bright line spectrum (Table I.)
† Probably a double.

After this paper was presented to the Society, a method of reproducing stellar spectra from orthochromatic plates, corrected for the sensibility curve of the plate, was suggested by Mr. W. McKeon, Assistant at this Observatory. It promises well enough to be recommended to other workers in stellar spectrography.

The orthochromatic negative is screened, during the enlarging exposure, by a reversal of the *continuous* spectrum of the negative. The screen is obtained as a glass positive of the orthochromatic continuous spectrum of a coal-gas light filtered through a blue glass during part of the exposure.

Theoretically the perfect screen is the positive of the *star's* continuous spectrum, and of the same density as the stellar negative. It is therefore necessary to have in readiness a large number of screens varying both in the relative intensities of the blue and yellow impressions and in general density. When these are prepared and labelled, it is not difficult to select the suitable screen for producing an enlargement of fairly uniform intensity.

Comparison of the Forthcoming Greenwich Ten-Year Catalogue for 1890, *with certain Fundamental Catalogues.*

(*Communicated by the Astronomer Royal.*)

In the preparation of the Greenwich Ten-Year Catalogue for 1890, the reduction of the fundamental stars has been completed in advance of the rest of the catalogue, as Dr. Auwers wished to be furnished with the results for use in the preparation of his New Fundamental Catalogue. The positions for 1890·0, given by the Greenwich Observations 1887–1896, have been obtained for the fundamental stars in the two catalogues of stars contained in the *Berliner Jahrbuch*, and, as a check on the numerical accuracy of the reductions, a comparison of the Greenwich results has been made with the catalogues of fundamental stars given in the *Berliner Jahrbuch* (Auwers), *American Ephemeris* (Newcomb and Boss), and Professor Newcomb's "New Fundamental Catalogue" adopted in the *Nautical Almanac* for 1901, and at the same time the systematic differences have been obtained. As the Greenwich Catalogue will probably not be completed for a year, it is of interest to give briefly the result of these comparisons.

In the New Greenwich Ten-Year Catalogue the methods of reduction are similar to those of the Ten-Year Catalogue (1880). Although the observations of the Sun showed a correction to the equinox, the changes in the observers made it probable that this was largely caused by differences of personality in observations of the Sun, and it was therefore considered better to apply no correction, but to keep the same equinox as that adopted in the 1880 Catalogue. The adopted colatitude and refractions are the same as in the 1880 Catalogue.

The Catalogues with which comparison has been made are—

(1) The Catalogue of 622 stars of the *Berliner Jahrbuch*. The places of these stars are based on Dr. Auwers' Fundamental Catalogue for the Zone Observations of the *Astronomische Gesellschaft*.

(2) The Catalogue of 303 stars given in the *Berliner Jahrbuch*, which is taken from Dr. Auwers' Fundamental Southern Catalogue for the Zone Observations of the *Astronomische Gesellschaft* between $-2°$ and $-23°$. This Catalogue, with an account of the observations on which it depends (mainly those of southern observatories) is given in *Ast. Nach.*, 1890–91.

(3) The *American Ephemeris*. The positions are derived from Professor Newcomb's Fundamental Right Ascensions and Professor Boss's Declinations.

(4) Professor Newcomb's New Fundamental Catalogue, which is adopted in the *Nautical Almanac* for 1901, but is not yet published. The places have been obtained from a manuscript copy supplied by the Superintendent of the *Nautical Almanac*.

Differences in Order of Right Ascension.

R.A.		Greenwich—B.J. R.A.	Greenwich—B.J. N.P.D.	No. of Stars.	Greenwich—"303" R.A.	Greenwich—"303" N.P.D.	No. of Stars.	Greenwich—A.E. R.A.	Greenwich—A.E. N.P.D.	No. of Stars.	Greenwich—Newc. R.A.	Greenwich—Newc. N.P.D.	No. of Stars.
h	h	s	"		s	"		s	"		s	"	
0 to	1	−·042	+0·21	9	−·028	+0·73	7	−·039	+0·25	9	−·071	+0·27	12
1 ,,	2	−·033	−0·28	9	−·020	+0·39	7	−·050	+0·06	7	−·058	+0·19	9
2 ,,	3	−·028	+0·23	10	−·018	+0·57	9	−·049	−0·02	10	−·056	+0·19	12
3 ,,	4	−·024	+0·02	13	−·036	+0·54	8	−·037	−0·13	10	−·057	+0·21	13
4 ,,	5	−·031	+0·04	7	−·034	+0·61	7	−·042	+0·02	6	−·050	+0·17	10
5 ,,	6	−·017	−0·06	12	−·003	+0·76	13	−·032	+0·04	9	−·051	+0·21	18
6 ,,	7	−·045	+0·17	10	−·040	+1·14	9	−·045	+0·03	9	−·058	+0·36	14
7 ,,	8	−·033	+0·15	9	−·055	+1·06	4	−·039	−0·01	6	−·052	+0·26	11
8 ,,	9	−·036	+0·36	7	−·025	+1·07	4	−·053	+0·23	6	−·063	+0·37	9
9 ,,	10	−·027	+0·15	8	−·015	+0·78	6	−·029	+0·11	7	−·053	+0·29	10
10 ,,	11	−·031	+0·28	11	−·037	+0·80	8	−·046	+0·11	5	−·056	+0·30	9
11 ,,	12	−·024	+0·03	9	−·014	+0·62	7	−·036	+0·04	7	−·053	+0·19	9
12 ,,	13	−·040	+0·23	3	−·021	+0·50	10	−·057	+0·18	7	−·056	+0·31	12
13 ,,	14	−·048	+0·22	4	−·021	+0·48	9	−·035	+0·03	5	−·051	+0·27	8
14 ,,	15	−·019	−0·17	8	−·025	+0·63	11	−·066	−0·13	7	−·053	+0·24	11
15 ,,	16	−·019	−0·01	13	−·021	+0·25	12	−·059	−0·01	7	−·051	+0·21	14
16 ,,	17	−·025	+0·34	8	−·023	+0·71	10	−·045	+0·35	5	−·051	+0·36	13
17 ,,	18	−·034	−0·26	7	−·010	+0·91	13	−·040	−0·10	7	−·053	+0·26	11
18 ,,	19	−·024	+0·12	11	−·030	+1·00	8	−·044	+0·15	7	−·047	+0·36	13
19 ,,	20	−·010	+0·22	10	−·012	+0·81	11	−·020	+0·18	7	−·045	+0·38	16
20 ,,	21	−·034	+0·11	10	−·008	+0·66	10	−·052	−0·03	7	−·058	+0·22	11
21 ,,	22	−·034	−0·03	10	−·009	+0·70	7	−·020	+0·01	7	−·046	+0·33	11
22 ,,	23	−·038	−0·07	12	−·021	+0·67	12	−·036	+0·19	8	−·062	+0·24	13
23 ,,	0	+·012	·00	6	−·021	+0·48	9	−·052	+0·57	3	−·054	+0·30	9

Differences in Order of North Polar Distance.

N.P.D.	Greenwich—B.J. R.A.	Greenwich—B.J. N.P.D.	No. of Stars.	Greenwich—"303." R.A.	Greenwich—"303." N.P.D.	No. of Stars.	Greenwich—A.E. R.A.	Greenwich—A.E. N.P.D.	No. of Stars.	Greenwich–Newc. R.A.	Greenwich–Newc. N.P.D.	No. of Stars.
° °	s	"		s	"		s	"		s	"	
0 to 10	+·078	−·13	11	...	...	...	+·018	−0·13	4	+·289	+·02	8
10 „ 20	−·054	−·09	43	...	...	...	−·043	−0·33	5	−·128	−·04	5
20 „ 30	−·054	−·21	47	...	...	...	−·072	−0·04	5	−·075	+·11	10
30 „ 40	−·032	−·13	34	...	...	...	−·036	−0·52	7	−·083	+·14	14
40 „ 50	−·045	−·17	52	...	...	...	−·052	−0·22	12	−·062	+·11	15
50 „ 55	−·034	+·24	27	...	...	...	−·065	−0·04	9	−·051	+·09	10
55 „ 60	−·040	+·01	24	...	...	...	−·053	−0·10	12	−·042	+·10	13
60 „ 65	−·037	−·17	31	...	...	...	−·062	−0·33	10	−·047	·00	19
65 „ 70	−·023	+·11	28	...	...	...	−·045	+0·06	15	−·050	+·16	25
70 „ 75	−·023	+·10	30	...	...	...	−·029	+0·05	9	−·058	+·11	19
75 „ 80	−·023	+·16	28	...	...	...	−·045	+0·24	19	−·055	+·29	23
80 „ 85	−·028	+·22	29	...	...	...	−·042	+0·07	20	−·060	+·36	30
85 „ 90	−·010	−·02	20	−·013	+·47	23	−·034	+0·14	9	−·057	+·31	19
90 „ 95	−·011	+·02	27	−·020	+·48	36	−·030	−0·02	12	−·057	+·30	24
95 „ 100	−·023	+·12	23	−·018	+·70	44	−·037	+0·15	18	−·060	+·34	23
100 „ 105	−·021	+·01	16	−·027	+·78	31	−·047	+0·02	8	−·060	+·49	14
105 „ 110	−·034	−·01	24	−·023	+·79	44	−·048	+0·18	9	−·057	+·56	22
110 „ 115	−·016	−·29	18	−·024	+·86	28	−·030	+0·43	6	−·056	+·50	19
115 „ 120	+·004	−·26	13	−·012	+·94	3	−·017	+0·43	11	−·040	+·46	19

1898 *April* 6.

Observations of the companions of Sirius and Procyon, made at the Royal Observatory, Greenwich.

(Communicated by the Astronomer Royal.)

The cloudy weather prevented any observation of *Sirius* during the early part of the year, and it was not till Sunday, March 20, that there was a night sufficiently good for the companion to be seen. On this night the position was measured by Mr. Lewis, as follows :—

		Position Angle.	Distance.
March 20	1898·214	179°·2	4″·68

The companion was also seen by Mr. Bryant and Mr. Melotte, but they did not make any measures. The difficulty of measurement was not due to the faintness of the companion so much as to the diffused image of *Sirius* at the low altitude.

The companion of *Procyon* has been observed on three nights by Mr. Lewis.

		Position Angle.	Distance.
		°	″
March 20	1898·214	327·7	3·93
March 31	·244	326·0	4·02
April 4	·255	324·4	4·84

On two nights the companion was seen by Mr. Melotte.

The observer noted that the appearance of the companion of *Procyon* was not so like a star as that of *Sirius*, and that while the wire of the micrometer totally eclipsed the companion of *Sirius*, the companion of *Procyon* was seen on both sides of the wire.

Royal Observatory, Greenwich :
1898 *April* 4.

Observations of Nebulæ. By Herbert A. Howe.

(*Communicated by the Secretaries.*)

In the latter part of 1897 September a series of micrometrical measures of nebulæ was begun by the writer at the Chamberlin Observatory, University Park, Colorado, U.S.A.

The working list contains all of Swift's nebulæ, and also a large number of others between the equator and 30° of south declination, the positions of which are not known to have been micrometrically measured. As the publication of this series of observations may be considerably delayed, it has been thought best to publish from time to time such preliminary results as may be of interest.

Each nebula is connected with some star in the field of view by micrometrical measures of $\Delta\alpha$ and $\Delta\delta$. The star, if not found in any good catalogue, is connected with some catalogue star by chronographic measures of $\Delta\alpha$, and micrometric of $\Delta\delta$. The last-mentioned observations are made at times when faint nebulæ are invisible because of the brightness of the Moon. The observations given below were made during the last four months of 1897 with the 20-inch Clark equatorial refractor armed with a magnifying power of 185 diameters. The mounting of the instrument was constructed by Sægmuller, and has proved to be very convenient for this work. When the positions of the nebulæ, as given in Dreyer's New General Catalogue, or in the supplementary catalogue in Vol. LI. of the *Memoirs of the R.A.S.*, are more than ten seconds in error in right ascension, or two minutes in declination, the correct positions are given. These places are, however, for 1900·0, which is the epoch of the working list.

By the liberality of Miss Catherine W. Bruce, of New York

City, a new micrometer has been built specially adapted to this work. Future observations will be made with it more swiftly and also more accurately than has been possible hitherto.

The numbers given are those of the N.G.C., except when the nebulæ are found in the supplementary catalogue above mentioned. In that case the numbers are inclosed in brackets.

24. The length of this nebula is 3′, the elongation being at 225°. A 9·5 mag. star is hard by its f extremity.

58. I cannot find this, having hunted diligently for it on two nights. Its neighbours 47 and 54 are easily seen. Probably the R.A. given for 58 is just a minute too great, and it is really identical with 47, which is a Tempel nebula.

73. Swift mentions a double star close following. Its mags. are 12, pos. angle 225°, and distance 20″.

155. The position is $0^h\ 29^m\ 37^s$, −11° 19′·4.

237. The position is $0^h\ 38^m\ 21^s$, −0° 40′·2.

283, 284, 285, 286. These are all eF, eS, with stellar nuclei of mag. 13·5. Their positions are

$0^h\ 48^m\ 14^s$, −13° 42′·4,
$0^h\ 48^m\ 25^s$, −13° 42′·1,
$0^h\ 48^m\ 31^s$, −13° 42′·1,
$0^h\ 48^m\ 31^s$, −13° 39′·3.

351. The position is $0^h\ 56^m\ 52^s$, −2° 28′·6.

481. The position is $1^h\ 16^m\ 13^s$, −9° 44′·1.

530. The position is $1^h\ 19^m\ 36^s$, −2° 6′·5.

589. The position is $1^h\ 27^m\ 44^s$, −12° 33′·4.

671. The position is $1^h\ 41^m\ 39^s$, +12° 37′·5.

675. The position is $1^h\ 43^m\ 53^s$, +12° 33′·5.

(164.) The position is $1^h\ 44^m\ 5^s$, −4° 24′·1.

715. The position is $1^h\ 48^m\ 20^s$, −13° 21′·9.

799. This has a good nuclear point of 13 mag. Its position is $1^h\ 57^m\ 6^s$, −0° 34′·9.

800. The position is $1^h\ 57^m\ 5^s$, −0° 36′·7.

809. The position is $1^h\ 59^m\ 23^s$, −9° 13′·0.

885. I have searched for this on three nights without success.

942–943. This I am inclined to call a very faint nebulous double star, the components being 35″ apart. The positions of the two objects considered separately are

943. $2^h\ 24^m\ 18^s$, −11° 16′·4.
942. $2^h\ 24^m\ 19^s$, −11° 16′·9.

Burnham also has examined these objects. His right ascensions agree with mine, but each of his declinations differs by nearly 1′. Probably his results were intended to be only approximate.

948. The position is $2^h\ 23^m\ 53^s$, −10° 57′·7.

(246.) The position is $2^h\ 35^m\ 18^s$, $+2°\ 2'·9$.

1091. The position is $2^h\ 40^m\ 43^s$, $-17°\ 57'·4$.

1092. The position is $2^h\ 40^m\ 50^s$, $-17°\ 57'·9$.
1091 and 1092 are both called vF by Leavenworth; 1092 is considerably brighter than its companion.

1639. This is described in N.G.C. as "eF, vS, R, bet. 2 st." I find no nebula, but simply an equilateral triangle of 12·5 mag. stars.

6797. This was searched for with considerable care on September 23. It was discovered by Peters, and is described as "Neb. with * 9 m att f." Not even the 9 mag. star could be found. The sky was clear, though clouds came a few minutes after the search was abandoned.

6835. This is about 30″ in length, and is elongated at 80°. Two condensations are suspected in it.

6836. There is a 13 mag. star involved; other extremely faint stellar points were seen, preceding this star. The nebulosity is faint and ill-defined, most of it preceding the 13 mag. star.

6924. This seems to be a nebulous star of mag. 14, accompanied by a 13 mag., 20″ south.

6936. There is considerable confusion about the place of this object. The places obtained by Leavenworth, Professor Ormond Stone, and myself are given below, being reduced to 1900·0 :—

Leavenworth ...	$20^h\ 30^m\ 33^s$,	$-25°\ 38'·0$.
Stone	$20^h\ 28^m\ 49^s$,	$-25°\ 45'·3$.
Howe	$20^h\ 29^m\ 59^s$,	$-25°\ 37'·5$.

As Leavenworth's declinations are usually much more accurate than his right ascensions, it seems probable that I have observed his nebula, and that Professor Stone has observed another object. I will examine the locality again next summer.

(1329.) Swift describes this as "eeF, pL, R, bet. 4 st., v diffic." I found the four stars, and within the quadrilateral formed by them I saw quite a number of minute stars, but was not sure of any nebulosity. The sky seemed free from haze.

6986. The position is $20^h\ 50^m\ 50^s$, $-18°\ 56'·9$.

6994. This cluster contains but four stars, of mags. 9–10, which form a letter Y.

7005. This is simply a coarse cluster, the three brightest stars being of mag. 9. No nebulosity is discernible.

7009. This planetary nebula is but slightly elliptical, being perhaps 15″ by 11″, the major axis having a position angle of about 70°. The colour is a beautiful greenish blue.

7010. I could find no nebula in the place given for this on

either one of two nights. But there is a nebula 10′ north of the given place, which is probably the one seen by h. However, the description "eF, pL, R, r" tallies only partially with mine, which is "eF, S, R, diffuse, with very faint nucleus."

The position is $20^h\ 59^m\ 11^s$, $-12°\ 44'{\cdot}1$.

7016, 7017, 7018. The positions of these extremely faint nebulæ are respectively

$21^h\ 1^m\ 25^s$, $-25°\ 52'{\cdot}3$,
$21^h\ 1^m\ 29^s$, $-25°\ 53'{\cdot}3$,
$21^h\ 1^m\ 34^s$, $-25°\ 49'{\cdot}8$.

7099. A cluster of marvellous beauty, the magnitudes ranging from 11 down. Its bright condensed centre is elongated at 100°. Following the main condensation, nearly 2′ from its centre, is a coarse group composed of a few 14 mag. stars. On the north side of the cluster the stars are scattered, bright, and arranged in lines. On the south side there are multitudes of stars of mag. 14.

7115. The length of the nebula was estimated to be 45″, and its breadth 10″. There is a 13 mag. star at the preceding end and a condensation at the following end; three or four other condensations were suspected lying along the axis. The position angle of the elongation was estimated as 65°.

The position is $21^h\ 37^m\ 53^s$, $-25°\ 48'{\cdot}6$.

7134. This was discovered by Peters, and is not a nebula; it is simply a group of three or four stars of mags. 13–14, which is about 40″ south of a 10 mag. star. A most careful scrutiny revealed no trace of nebulosity.

7136. This is a stellar object of mag. 13, which Muller suspected to be a nebula. At times it looked slightly nebulous, and at other times distinctly stellar. Nothing is visible in the place given in the N.G.C.

The position is $21^h\ 44^m\ 20^s$, $-12°\ 15'{\cdot}5$.

7159. Swift says "vF * sf." I find the star to be involved in the nebula.

7208. This could not be found in the position given in the N.G.C., but a nebula corresponding to the description precedes a minute. It is in line between two stars of mags. 10·5 and 11·5, 5′ apart.

The position is $22^h\ 2^m\ 41^s$, $-29°\ 32'{\cdot}4$.

7220. The position is $22^h\ 5^m\ 57^s$, $-23°\ 26'{\cdot}8$.

7246. In the N.G.C. this is given as "vl E, vgb M, * 13 n." To me the elongation seems very decided at 180°; there is a nuclear condensation of mag. 14. The star north of the nebula is of mag. 10.

7254 and 7256. These are identical. The place of 7254 is wrong in right ascension, and the place of 7256 is 10′

wrong in declination. I could find only one nebular object in this vicinity. Two of the three faint stars involved, and mentioned by Marth were seen; the third was suspected. The northernmost one was brightest, and was of mag. 14. The 11 mag. star which Muller saw 4′·5 preceding the nebula was also observed.
The position is $22^h\ 17^m\ 6^s$, $-22°\ 14'·5$.

7269. The position is $22^h\ 20^m\ 27^s$, $-13°\ 40'·5$.

7284 and 7285. The description of 7284 in the N.G.C. is "cF, cS, lE, r, D * inv." The description of 7285, discovered by Lassell, is "Nebs. * 1′ dist. from 7284." I judge 7285 to be simply one of the components of 7284. Both seemed to be nebulous stars. The brighter one is of mag. 12·5. The other is of mag. 13, and lies at position angle 60°, distant about 40″. Neither of the stars appeared to be double. I could not see any nebulosity uniting them, but the sky was somewhat dull. No other star bright enough to have been noted by Lassell is within 5′.

7413. The position is $22^h\ 50^m\ 4^s$, $+12°\ 41'·3$.

7425. The position is $22^h\ 52^m\ 1^s$, $-11°\ 29'·1$.

(1463.) This was discovered by Engelhardt, and is described as "neb. st. 14 m." I find in this place simply a faint double star, of distance 20″ and angle 45°. It is within a trapezoid of 10 mag. stars, the two long sides of the trapezoid being about 5′ in length.

7492. The nebulous matter is extremely faint, and besprinkled sparsely with stars of mag. 14. I can distinguish no definite form; the nebula is perhaps 2′ in diameter. It is described as being "bet. 2 D st." I find only one double which follows, and is of mags. 12 and 12·5, having a position angle of 160°, and a distance of about 40″. Though this double is thus wide and faint, there is no double as interesting preceding the nebula. There are a few scattered faint stars there.

7580. The position is $23^h\ 12^m\ 19^s$, $+13°\ 27'·6$.

7656. The position is $23^h\ 19^m\ 17^s$, $-19°\ 36'·4$.

7709. This is described as "R." I find it much elongated at 225°. It lies 8′ south of a star of 8 mag. Its length is 20″, with a possible further faint extension.
The position is $23^h\ 30^m\ 15^s$, $-17°\ 15'·4$.

7736. This follows a star of mag. 8 about 30 seconds, 3′ south. Professor Stone's description tallies with my observations except that he calls it "eF, gb M," while to me it appeared to have a bright centre equal to a 12·5 mag. star.
The position is $23^h\ 37^m\ 14^s$, $-20°\ 0'·4$.

7761. I cannot find nebulæ in the places given in N.G.C. for 7761 and 7776, but find one at $23^h\ 46^m\ 20^s$, $-13°\ 56'·2$. 7761 is supposed to precede this $2^m\ 1^s$, and 7776 to follow mine, $1^m\ 14^s$. The descriptions of 7761 and 7776 agree pretty well with each other and with mine. However, my

nebula follows a star of mag. 9 by 3′·5, while Professor Stone describes 7761 as following a 10 mag. by 8′. Perhaps a larger telescope is required to settle the question whether 7761 and 7776 are identical with the nebula which I have found between the places assigned for them.

7803. The position is $23^h\ 56^m\ 13^s$, $+12°\ 33'·3$.

7821. In the N.G.C. this is described as iF. Probably iR is meant. The nebula is about 40″ long and 15″ broad, the elongation being at 110°.

7828. The position is $0^h\ 1^m\ 20^s$, $-13°\ 58'·3$.

7829. This follows 7828 two seconds. Leavenworth suspected it to be a nebula. I can see no nebulosity ; it appears to be simply a star of mag. 13.

Second Attempt to Photograph the Leonid Meteor Swarm.
By Isaac Roberts, D.Sc., F.R.S.

The first attempt to photograph the *Leonid* Meteor Swarm was made last year, and was reported upon to the Society at the meeting held in 1897 March (*Mon. Notices*, vol. lvii. pp. 430–431).

This second attempt was made by using the ephemeris computed by Mr. Wright, of the *Nautical Almanac* office, under the directions of Dr. G. Johnstone Stoney and Dr. Downing. It included the interval between 1897 December 24 and 1898 April 8 ; but unfortunately the only occasions with suitable climatic conditions for taking photographs, within the range of the ephemeris, were on 1897 December 31 ; 1898 February 27 and March 21.

The photographs were taken simultaneously with the 20-inch reflector and the 5-inch Cooke lens, the reflector plates covering the sky area of four square degrees, and the lens an area of 230 degrees.

The December plates were exposed during 57 minutes, and the February and March plates exposed during two hours each respectively.

The sky during the exposures on each occasion was clear, and the general conditions must be considered favourable for obtaining good photographs. The stars on the plates with two hours exposures in the 20-inch reflector would be to the faintness of about 17th magnitude, and on the 5-inch lens plates about 14th to 15th magnitude.

The sum of this explanatory statement is, that after very careful examination of all the plates, three times over, no indication whatever could be perceived of the presence of the meteor swarm. We must therefore conclude that if the ephemeris is correct within the limits of the photo-fields stated above—if the meteor swarm has followed the computed orbit, in the computed

time, we must accept the photographic evidence that the meteors are very small—that they are, over the area of $2° \times 2°$, fainter than 17th magnitude, or over 230° area, fainter than 15th magnitude stars.

I am willing to try again to photograph the swarm during a period extending from December 24 this year to the end of the first week in April next year, provided an ephemeris is computed for the purpose ; for I am impressed with the idea that the luminosity, and accurate position of this swarm in its orbit, ought, if possible, to be determined with the necessary accuracy, and the photographic method only can adequately furnish the data.

A Revolver Eyepiece, electrically warmed. By A. F. Lindemann.

Especially in observing double stars and planetary details I had often and rapidly to change the magnifying power of my telescope. The air would allow a power of 100; suddenly it becomes steadier for a few seconds and a power of 200 to 300, or even 420 to 600, can be used with my 6-inch glass. But before 1895 it took me 15 to 30 seconds to change it, and during this time the air often changed unfavourably, and I had to return to 100. Quite apart from having perhaps to focus the changed power a little, to light up and take my eye off the telescope, and spoiling by change of illumination the sensitiveness of the retina for the next 5 to 10 seconds, in winter—or even in a very damp and cool summer night—the new cold eyepiece, when in position, just at the most important moment, would suddenly cover with condensed moisture from the eye, and a wiping process had to be resorted to. Even when the eyepiece was previously warmed, it often cooled down during observation, and gave the same deplorable result. This induced me to construct and make an eyepiece which I have now had over three years in constant use, and which proves to be all that can be desired. The idea of a revolver eyepiece is not a new one, as at least one "vertically" revolving eyepiece exists ; but my construction may have some new features, and may be of use to others as it has been to me ; and the (I believe) novel idea of warming by electricity should certainly prove a boon to nearly every observer, as it can easily be applied to any telescope.

The revolver eyepiece (figs. 1, 2, 3, 4, and 5) consists of a ring (*a*) of ebonite (which I largely use with advantage), to which is screwed the ebonite carrier (*b*). The ring and carrier is slipped over the tube (A), usually carrying the eyepieces (figs. 1 and 2) up to collar (*c*). By this the position of A in relation to *a b* is fixed. The clamp screw (*e*) holds it tight in any position by pressing a small steel plate (*d*) in the usual way against A. When *e* is released *a b* can be rotated round A. Upon A is very carefully

Fig. I.

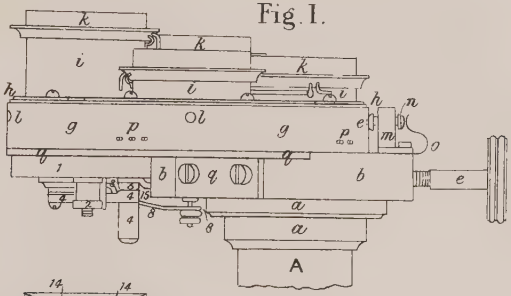


Fig. II.

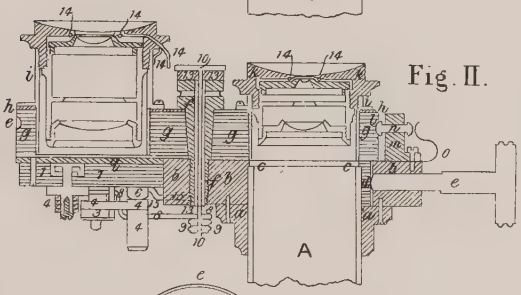


Fig. III.

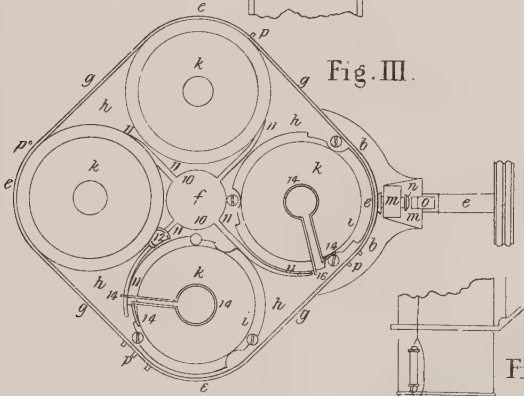


Fig. V.

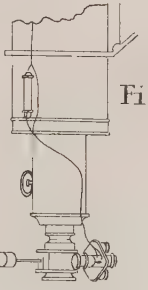
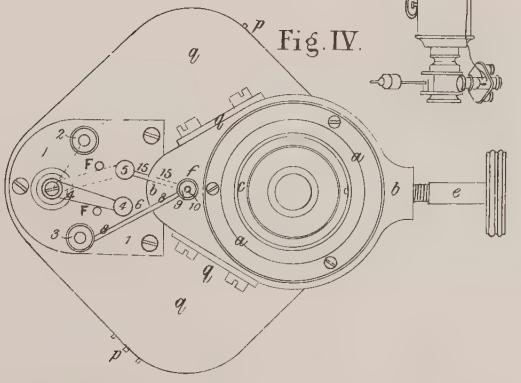


Fig. IV.



fixed the ebonite piece (*g*) by means of a cone and screw (*f*). *g* rotates, and is for convenience' sake made square, with rounded corners. I choose this shape so that the eye can easily be brought over the eyepiece. Even a pentagon disturbs the bringing up of the eye, as the nose and eyebrows are in the way. The piece *g* is in four places, and at right angles to one another, carefully pierced, so that the centres of the eyepieces to be inserted are in the same circle, central to *f*, and in the optical axis of the telescope. In these holes are inserted the eyepieces (*i i i i*) of various magnifying powers, and at such varying heights that the focus of all of them is in the same plane. The eyepieces fit smoothly in the holes and are fixed as seen in the drawings (figs. 1, 2, and 3), being held by turning them under the screw heads as shown. In turning *g* one power after the other is placed exactly over *a b*, and the power changed within half a second.

Now as to details. At *m* there is a slip-bolt (*n*), rounded off towards *g*, against which it presses by a spring (*o*). In *g* conical holes (*l*) are drilled, so that when the bolt (*n*) falls in one, the respective eyepiece is exactly over the centre of A; the telescope is now focussed, and the star having been set in centre of one eyepiece will be found to stand also in the centre of this or any other which may be set. The small resistance given by the bolt against turning enables the hand to feel that the eyepiece is in position. At *p p p* are fastened near the corner, and convenient for the hand to feel, small rounded pins, which in the dark tell, by the number of them felt, what power is in hand, so that any power can be determined and easily set. An aluminium plate (*q q*) is fastened to *b* so as to protect the eyepieces from beneath against injury and dust, and is at the same time the carrier of the commutator (1).

Now as to warming. This is at present done by electricity from the primary battery, but in future will be supplied by a central storage battery. At 1 is fixed to the above-mentioned aluminium plate (*q*) a small commutator, 2 and 3 are the two pole clamp screws, 4 is the contact lever. The current travels along the telescope tube by covered wires to a resistance coil (fig. v.) with variable resistance, and from thence by a pliable silk-covered copper strand to 2 and 3. 2 is connected by a thick silver wire (15) to the screw foot (*f*). From 3 a thick hard-drawn silver wire (8) stretches to and round the thick silver wire (10), where it rests by spring action against the silver nut (9) set fast by check nut. This wire (10) passes through the ebonite plug and plate (13 . 13), inside screw and cone (*f f*) to the top of it, ending in plate 10, which itself stretches out in four arms (11 . 11 . 11 . 11). Fixed to *g g* is the aluminium plate *h h*, making good contact with the head of *f f*, and with the tubes of the eyepieces (*i i i i*). By these means pole 2 is connected with all eyepiece tubes. The other pole (3) ends in the four arms (11 . 11 . 11 . 11) of thick hard-drawn silver wire, bent according to height of eyepiece as needed, and flattened at the ends, and taking the pole (3) close to the four

eyepiece tubes. The eyepiece has a head of ebonite, which screws into the eyepiece tube. This head is pierced by a thin platinoid wire (14 . 14) towards the centre, where it forms a ring and returns to the outside, where one end is bent short and flattened, making good spring contact with the tube *i* by means of a short silver strip soldered to *i*, and thereby connects pole 2. The other end of 14 stretches a little further out, and is bent sharply downwards and flattened, making good contact with the wire (11), which presses it outwards by spring action, and is therefore connected with pole 3. The eyepiece (fig. III.) on the right is to show it out of circuit, and that by turning it to the left and bending the wire 11 towards the wire 14 it will catch it and set the eyepiece for warming (see lower eyepiece in fig. III.). To insert another eyepiece, turn the one to be taken out about 10° to the right, lift it out, and fix the other by turning it the other way.

The action is the following (dotted lines show connection of commutator parts) : To turn the current on, place handle 4 upon 5; current runs from 2 to 4 and 5, by 15 to screw *f* to plate *h* to four eyepieces (*i i i i*), to platinoid wires (14 . 14 . 14 . 14), from thence to arms 11 . 11 . 11 . 11 to centre (10), down to 9 and 8 and to pole 3. By this arrangement the circuit remains unbroken, although *g* is rotating. When electricity is turned on and resistance regulated, the four platinoid rings are gently warmed, and by radiation the four eyepiece lenses next to the eye are also warmed in a few minutes, so that condensation of water upon them is impossible. Before constructing this warming arrangement I considered well the effect of warming upon the eyepiece lens, but the effect is practically nil, especially as the heating is central and gentle, as it only requires a few degrees to prevent dew deposit. I have not determined the current required, as I had plenty of it, but it is of course a very simple matter for anybody to work out. It must, however, be considered that the current splits at 10 in four parts. I find the platinoid gives a very good resistance. The sliding resistance makes the regulation very simple and perfect. Perfect contacts and careful insulation of wires are of course most important ; especially platinoid wires (14 . 14) must be kept well away from brass setting of lens. I have other methods for warming, but found this one the most simple and convenient, as the eyepiece can be released and exchanged in less than ten seconds. When using more than four powers it is, however, more practical to have two or three sets of four, each ready and connected to the respective wires, as the whole set can then be exchanged in less than ten seconds. I may mention that the head of the clamp screw, eyepiece tubes, commutator handle, and counter weight are painted with Balmaine's paint, also a ring round A and *a* : this helps greatly when exchanging, saves one's head, and the eye finds at once the eyepiece, no other illumination being required.

Advantages.

1. Four different powers can be used in rapid succession of half-second each, thereby making use of every fraction of time of perfect air. In this way I separated ω *Leonis* to perfection on 1895 February 28, during a fine night. But the 5 to 10 seconds of absolutely perfect vision could only be gained by this or a similar instrument, or in the ordinary way accidentally.

2. Eight to twelve powers are at disposal in sets of four each, with intervals of less than 10 seconds for each set.

3. The eyepieces are always in focus if one eyepiece is once set for colour of object.

4. The eye need not be removed from eyepiece during change of powers.

5. The revolver allows a sweep over the whole field of the object glass in any direction, a very considerable advantage, especially with higher powers. I usually set it by *e* to sweep in R.A., and then turn 90° and sweep in declination; very convenient when searching for an object of which ephemeris is not quite exact. In this way I found Brooke's Comet.

6. The very objectionable condensation is entirely obviated.

Disadvantage.—Perhaps slightly complicated, and extreme nicety in construction imperative.

I have the first eyepiece I made in use since 1895 January 16, and learned to value it more and more every starlight night. Professor Schiaparelli and Professor Max Wolf were very pleased with this instrument, especially the latter, who is himself no mean mechanic, who worked with it, and photographed it at Sidmouth in October 1896, and strongly recommended me to publish the above description of it.

Sidmouth Observatory:
March 25, 1898.

Times of Transit of the Zero Meridians of the two adopted Systems across the centre of the illuminated disc of Jupiter, 1897–98. By A. C. D. Crommelin.

In compliance with numerous requests I have computed the following list of the times of transit of the zero meridians across the centre of the illuminated disc of *Jupiter*. Those passages are given which occur next after noon on those days for which the longitude of the central meridian at noon was given in my previous ephemerides. Thus five rotations intervene between the tabulated transits, except in the case of those marked with an asterisk, which are separated from those preceding them by four rotations only. Intermediate passages can be found either by interpolation, or, with sufficient accuracy for most purposes, by applying to the nearest transit in the tables once or twice the

rotation period, which may be taken as $9^h\ 50^m{\cdot}5$, $19^h\ 41^m{\cdot}0$ for System I., and as $9^h\ 55^m{\cdot}5$, $19^h\ 51^m{\cdot}0$ for System II. :—

	System I. G.M.T.	System II. G.M.T.		System I. G.M.T.	System II. G.M.T.
	h m	h m		h m	h m
Dec. 10	5 47·8	6 3·4	Feb. 20	0 0·1*	5 26·2
12	7 0·5	7 42·0	22	1 12·2	7 4·0
14	8 13·1	9 20·6	24	2 24·4	8 42·0
16	9 25·7	1 3·3*	26	3 36·4	0 24·4*
18	0 47·8*	2 41·8	28	4 48·4	2 2·3
20	2 0·3	4 20·3	Mar. 2	6 0·5	3 40·3
22	3 12·9	5 58·8	4	7 12·5	5 18·2
24	4 25·5	7 37·1	6	8 24·6	6 56·0
26	5 38·0	9 15·6	8	9 36·5	8 34·1
28	6 50·5	0 58·3*	10	0 58·2*	0 16·3*
30	8 2·9	2 36·7	12	2 10·3	1 54·2
Jan. 1	9 15·3	4 15·0	14	3 22·3	3 32·2
3	0 37·4*	5 53·3	16	4 34·3	5 10·1
5	1 49·8	7 31·7	18	5 46·4	6 48·0
7	3 2·3	9 9·9	20	6 58·3	8 25·9
9	4 14·6	0 52 6*	22	8 10·6	0 8·2*
11	5 27·1	2 30·9	24	9 22·6	1 46·1
13	6 39·4	4 9·2	26	0 44·2*	3 24·1
15	7 51·8	5 47·3	28	1 56·2	5 2·1
17	9 3·9	7 25·6	30	3 8·3	6 40·0
19	0 26·0*	9 3·8	Apr. 1	4 20·3	8 18·0
21	1 38·2	0 46·4*	3	5 32·5	0 0·4*
23	2 50·5	2 24·5	5	6 44·6	1 38·5
25	4 2·8	4 2·6	7	7 56·8	3 16·4
27	5 15·0	5 40·8	9	9 8·9	4 54·5
29	6 27·2	7 18·8	11	0 30·8*	6 32·6
31	7 39·6	8 57·0	13	1 43·0	8 10·7
Feb. 2	8 51·7	0 39·5*	15	2 55·2	9 48·7
4	0 13·5*	2 17·6	17	4 7·5	1 31·3*
6	1 25·7	3 55·6	19	5 19·7	3 9·5
8	2 37·8	5 33·7	21	6 32·0	4 47·6
10	3 50·0	7 11·7	23	7 44·4	6 25·9
12	5 2·1	8 49·7	25	8 56·8	8 4·1
14	6 14·2	0 32·1*	27	0 18·7*	9 42·3
16	7 26·3	2 10·1	29	1 31·1	1 25·1*
18	8 38·5	3 48·1	May 1	2 43·6	3 3·4

	System I. G.M.T.	System II. G.M.T.		System I. G.M.T.	System II. G.M.T.
	h m	h m		h m	h m
May 3	3 56·0	4 41·8	June 26	7 9·5	9 23·0
5	5 8·4	6 20·1	28	8 22·5	1 6·2*
7	6 20·9	7 58·6	30	9 35·6	2 45·1
9	7 33·5	9 37·0	July 2	0 58·1*	4 24·1
11	8 46·1	1 19·6*	4	2 11·2	6 3·1
13	0 8·2*	2 58·1	6	3 24·2	7 42·1
15	1 20·8	4 36·6	8	4 37·4	9 21·2
17	2 33·4	6 15·1	10	5 50·6	1 4·4*
19	3 46·1	7 53·8	12	7 3·7	2 43·4
21	4 58·7	9 32·3	14	8 16·7	4 22·4
23	6 11·4	1 15·1*	16	9 29·9	6 1·6
25	7 24·2	2 53·8	18	0 52·6*	7 40·6
27	8 37·0	4 32·3	20	2 5·8	9 19·7
29	9 49·7	6 11·0	22	3 19·0	1 2·9*
31	1 11·9*	7 49·7	24	4 32·1	2 42·1
June 2	2 24·7	9 28·5	26	5 45·2	4 21·1
4	3 37·6	1 11·5*	28	6 58·4	6 0·3
6	4 50·5	2 50·2	30	8 11·8	7 39·4
8	6 3·4	4 28·9	Aug. 1	9 25·0	9 18·5
10	7 16·3	6 7·8	3	0 47·6*	1 1·8*
12	8 29·2	7 46·5	5	2 0·9	2 40·9
14	9 42·1	9 25·4	7	3 14·1	4 20·1
16	1 4·5*	1 8·5*	9	4 27·4	5 59·3
18	2 17·5	2 47·3	11	5 40·6	7 38·4
20	3 30·4	4 26·2	13	6 53·8	9 17·5
22	4 43·4	6 5·1	15	8 7·1	1 0·9*
24	5 56·5	7 44·0	17	9 20·4	2 40·1

7 *Vanbrugh Park Road, Blackheath, S.E.:*
1898 *April* 6.

Elongations of Jupiter's Fifth Satellite, 1898 *April* 10 *to June* 19.
By A. C. D. Crommelin.

The period adopted in the American Ephemeris, viz. $11^h\ 57^m\ 22^s{\cdot}6865$, has been employed. This is sensibly the same as the definitive value $11^h\ 57^m\ 22^s{\cdot}6790$ deduced by Dr. Cohn from all the observations made up to 1895 January 30, the difference only amounting to about 1 minute in 10 years. Every fourth elonga-

tion is tabulated ; the intermediate ones may be found by the application of $11^h\ 57^m$ or $23^h\ 55^m$ to the nearest tabulated elongation.

1898.	East Elongns. G.M.T. h m	West Elongns. G.M.T. h m		East Elongns. G.M.T. h m	West Elongns. G.M.T. h m
Apr. 10	15 23	21 22	May 16	12 11	18 10
12	15 13	21 12	18	12 0	17 59
14	15 2	21 1	20	11 50	17 49
16	14 52	20 50	22	11 39	17 38
18	14 41	20 40	24	11 29	17 28
20	14 30	20 29	26	11 19	17 17
22	14 19	20 18	28	11 8	17 7
24	14 8	20 7	30	10 58	16 57
26	13 58	19 56	June 1	10 48	16 47
28	13 47	19 46	3	10 38	16 37
30	13 36	19 35	5	10 28	16 26
May 2	13 25	19 24	7	10 17	16 16
4	13 14	19 13	9	10 8	16 7
6	13 4	19 2	11	9 58	15 56
8	12 53	18 52	13	9 48	15 47
10	12 43	18 41	15	9 38	15 37
12	12 32	18 31	17	9 29	15 28
14	12 21	18 21	19	9 19	15 18

Errata in Mr. Marth's Values of the Sun's Co-longitude, MONTHLY NOTICES vol. lvii. :—

(*Communicated by A. C. D. Crommelin.*)

Page 88, Aug. 22, *for* 218°·82 *read* 205°·82.

" " 23, *for* 230°·05 *read* 218°·05.

" " 24, *for* 242°·29 *read* 230°·29.

Page 614, Nov. 19, *for* 201°·64 *read* 210° 64.